Thomas Fire – Burned Area Emergency Response

Soil Resource Report – Phase II Assessment

Jameson Reservoir looking northeast

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Executive Summary – Soil Resource Condition Assessment:

The Thomas Fire burned approximately 281,893 acres between Santa Barbara and Ventura, in same-named counties, CA. There was a Phase 1 Burned Area Emergency Response (BAER) Team assessment focused in the Ojai area prior to efforts for Phase 2 assessment documented here. Phase 2 assessment includes mapping soil burn severity (SBS) on the remaining approx. 240,000 acres of the fire, and Values at Risk (VAR) assessment and erosion modeling on approx. 180,000 acres of Forest Service lands and select private lands in coordination with state WERT teams conducting similar assessments on private lands. The BAER Team found the overall soil burn severity to be 10% unburned & very low, 23% low, 65% moderate, and 1.5% high for the entire fire area. The unusual lack of more high is attributed to lack of dense forest ecotypes and the rapidly-moving nature of the fire (short residence time of soil heating). Severe soil heating was fairly rare and restricted to steep ridgetop areas, presumably with pre-heating of fuels from fire progression patterns. Vegetation is predominantly chaparral-southern coastal scrub with some watersheds having a mix with grasslands and/or mixed hardwood forest ecotypes, the latter mainly in riparian corridors with more soil moisture availability.

Very little of the mapped high SBS was accessible to confidently characterize fire-wide. Moderate SBS has fairly intact soil structure with presence of most fine roots, albeit charred in the surface 1-3 cm, and the natural seedbank should be only modestly affected boding well for natural recovery in the future. However, soil water repellency was very common within moderate and high SBS, estimated in 40-60% of these areas, and present but spotty in low soil burn severity areas. The moderate SBS areas are estimated to largely have a watershed response similar to typical high SBS in terms on runoff production, but should not be quite as erodible given modest storm intensities. Low SBS areas still have good surface structure, contain intact fine roots and organic matter, and should recover in the short-term once revegetation begins and the soil surface regains more cover for erosion protection. VARs upon NFS lands are invariably linked to rather large areas of moderate SBS upon slopes above; identified VARs are mainly road and trail infrastructure, and a few archaeology sites. There are NO land treatments for conservation of soil productivity proposed; we do have some high rates of modeled erosion within the assessment areas, but seasonal timing and implementation feasibility are unfavorable for committing such effort and resources toward unknown winter storm scenarios, while in the winter season. Off-site hazards of erosion source areas are present and serious, possibly posing high risks to life and property; ability to manage these risks is very limited because of both challenging topography and timing.

As of this writing, hazardous events in the form of debris-flow have occurred in lethal and severely-damaging fashion in the community of Montecito, underlying source areas between Cold Springs Canyon to Romero Canyon. While devastating and sobering, it should be understood from an earth-science perspective that similar hazards are not necessarily diminished or unforeseen in this or other areas (such as Carpinteria and Ojai) underlying the Thomas Fire footprint, given future severe storm events in the next several years prior to natural revegetation, soil-cover recovery, and natural diminishment of soil water repellency. A repeat of similar catastrophe could happen – many channels in upper watersheds are still primed with available materials (soil, rocks, and boulders) that could be mobilized with the next storm events. Communities below must keep awareness of weather forecasts, remain vigilant, and have plans for their personal safety to be implemented if the situation warrants.

1. General Situation Report

1.1 Thomas Fire Inter-Agency BAER Team

The Thomas Fire burned largely on the Los Padres National Forest, including private lands within and on the downslope periphery of the fire. The fire is being described as the largest fire in California history. The BAER team was formed to address the range of concerns, values at risk, and potential treatments upon NFS lands and across ownerships with the aim to coordinate efforts and maximize potential treatment effectiveness within whole watershed units at scale. Soil Scientists and other earth scientists familiar with SBS procedures working on the team include the following:

Eric Nicita, Forest Soil Scientist, Eldorado NF, Placerville CA
Doug Peters, Forest Soil Scientist, Lassen NF, Susanville CA
Emily Fudge, Hydrologist, Cleveland NF, San Diego CA
Vince Pacific, Hydrologist, Eldorado NF, Placerville CA
Hannah Grist, Geologist, Malheur NF, John Day OR
David Young, R5 North Zone Soil Scientist, USFS Region 5, Redding CA
Anna Courtney, District Soil Scientist, Shasta-Trinity NF, McCloud CA
Brad Rust, Forest Soil Scientist, Shasta-Trinity NF, Redding CA

Some scientists above worked on soil burn severity (SBS) mapping efforts only; some worked on the BAER team; some worked through the duration of both. More specifically, there was an "advance team" led by Eric Nicita formed just after Christmas using some of these scientists to focus upon mapping SBS. The rest of the BAER team and state WERT teams formed the following week so they could 'hit the ground running' with verified SBS and USGS debris flow modeling information in-hand from the start. Brad Rust was the BAER Team Leader.

There was close and continuous interagency coordination to divide the fire area and various-agency skills on site to conduct the assessment as rapidly as possible. These teams initially worked out of county OEM offices in Ventura and Santa Barbara to coordinate and communicate intel with OEM in real time, and remained in close and continued coordination with each other after the storm event situation necessitated relocation of the BAER and Santa Barbara WERT teams.

A decision was made early that for USFS BAER erosion modeling efforts, only the NFS lands and the Front Country portion of the fire area from San Antonio Creek to Santa Barbara would be modeled, an area approximately 180,000 acres, for use specifically between the FS-BAER and the Santa Barbara and Ojai WERT teams. This is in addition to the Ojai portion already mapped by USFS with the initial assessment, 42,000 acres, similar as below. Ventura County expressed capability and willingness to model erosion (in addition to hydrology) for the watersheds draining to the Santa Clara River and communities east of San Antonio Creek to the Santa Clara River frontage in Ventura County, with a separate Santa Paula-Santa Clara WERT contingent assessing VARs for that portion of the fire area.

The BAER team focused on VARs and risk-assessment on NFS lands, and worked in close cooperation daily to compare notes, safety concerns, identified VARs, risk assessments, and treatment possibilities. The soils team also worked closely with other resource specialists on the team, local FS employees, and other external cooperators as appropriate to the situation.

1.2 Summary of soil conditions

The Thomas Fire occurred in an unusual mix of geologic strata involving original sedimentary lithology, folded and faulted, and further metamorphosed; soils from these parent materials have an unusual variety of textures from gravelly sandy loams to silty clay loams to proper-clays, and varying further in rock content and depth phases. Each of these soils are erodible given different erosion-environment conditions, absent fire effects.

Dominant soils include: Inks-Lodo-Agua Dulce families complex, 30-80% slopes; these are gravelly sandy loams on approx. 30,936 acres. Illerton-Reliz-Modjeska families association, 40-70% slopes, are gravelly sandy loams on approx. 17,675 acres. Yorba-Modjeska-Morical families association, 30-60% slopes, are loam texture on approx. 17,334 acres. Yorba-Millsholm-Stonyford families association, 30-60% slopes, are sandy loams on approx. 15,348 acres.

Most soils at ridgetops and higher elevations are formed from hard shale and fine grained sandstones; they are relatively shallow due to higher rates of natural background erosion on steep slope gradients. Soils on lower slopes are mainly formed from mixed alluvium, and they are deeper with higher natural productivity due to more soil profile development on gentler slopes. These are gross generalizations. We found that soil types are fairly predictable from the geology mapping which atypically has better resolution than soil mapping in this area, at least upon NFS lands.

Vegetation is predominantly chaparral dominating the landscape, with some watersheds having a mix with grasslands and/or mixed-hardwood woodlands. Chaparral typically burns at low to moderate soil burn severity; here many chaparral communities were quite mature due to time since last fire, and fire behavior was severe, creating predominantly moderate soil burn severity and nearly complete consumption of vegetation upon most slopes outside of hardwood riparian areas.

Two-thirds of the fire area resulted in moderate soil burn severity. These areas have obvious evidence of soil heating, generally just in the surface inch of soil, but have complete lack of cover and widespread and fairly continuous water repellency. They will therefore have a watershed response similar to a high SBS, and will produce significantly increased runoff, sediment production, and stream flows. The natural seedbank and root crowns of resprouting species are not severely affected in moderate SBS, so re-vegetation of these areas is expected to be fairly average, with 60-100% canopy cover over 3-7 years barring another extended drought. The areas of high soil burn severity were on steep upper slopes and show deeper char, discoloration, some destruction of organic matter and structure in the top 2-3 inches, and likewise have moderate to severe water repellency. These areas have long-term soil damage, and natural recovery will be slow without active restoration treatments in the short to medium term (beyond BAER).

The slopes dominated mostly by grasslands are geologically formed on the sedimentary strata of the Pico formation. These burned in flashy fashion with little residence time, resulting in mostly low soil burn severity. Grasslands very typically do result with low soil burn severity because of lower total biomass (BTUs) for soil-heating. In total acreage, 33% of the burned area had unburned and low soil burn severity, showing very little evidence of significant soil heating with essentially no changes in soil color, structure, organic matter or fine root combustion. Seed source was present in most topsoils and natural regeneration is already beginning in some areas with adapted sprouting species. These areas currently have >50% soil cover, and understory growth is expected to progress relatively quickly.

Process geomorphology is quite active in this region, even without fire, but natural hillslope processes are greatly accelerated after fire, and over geologic time post-fire erosion is a major geomorphic factor. Many areas have extensive evidence of shallow-seated debris slides and debris flow history. Old gullying and topsoil erosion is observable in many areas, and many headwall-type slopes are 'rock-armored' from past erosion of fine materials. Dry ravel processes were occurring in real time post-fire during the assessment; these materials were pre-loading ephemeral channels higher in the watersheds, creating concerns for the additive contribution to available materials for debris flow processes. Most soils with the absence of cover will produce significant erosion and sediment delivery to stream systems. Elevated post-fire flows and erosion/sediment loads will persist over 3-7 years or more, commensurate with rates of vegetation regrowth and soil cover establishment.

2. Soil Inventory

Soil coverage was obtained from the NRCS (USDA Natural Resources Conservation Service), which incorporates soils information and mapping on all ownerships in the area. The fire area was covered by 3 soil surveys, with 130 soil map units within the fire perimeter. Corresponding map unit data and interpretations were obtained for further analyses. This provided the basic soil information for making interpretations of fire effects upon the various soils, particularly as many areas were not field visited due to access and time constraints. Soil Map Units are displayed in Figure 1, and map unit names and acreage within the fire perimeter are in Appendix A. Figure 1 also displays the analysis area used for soil erosion modeling

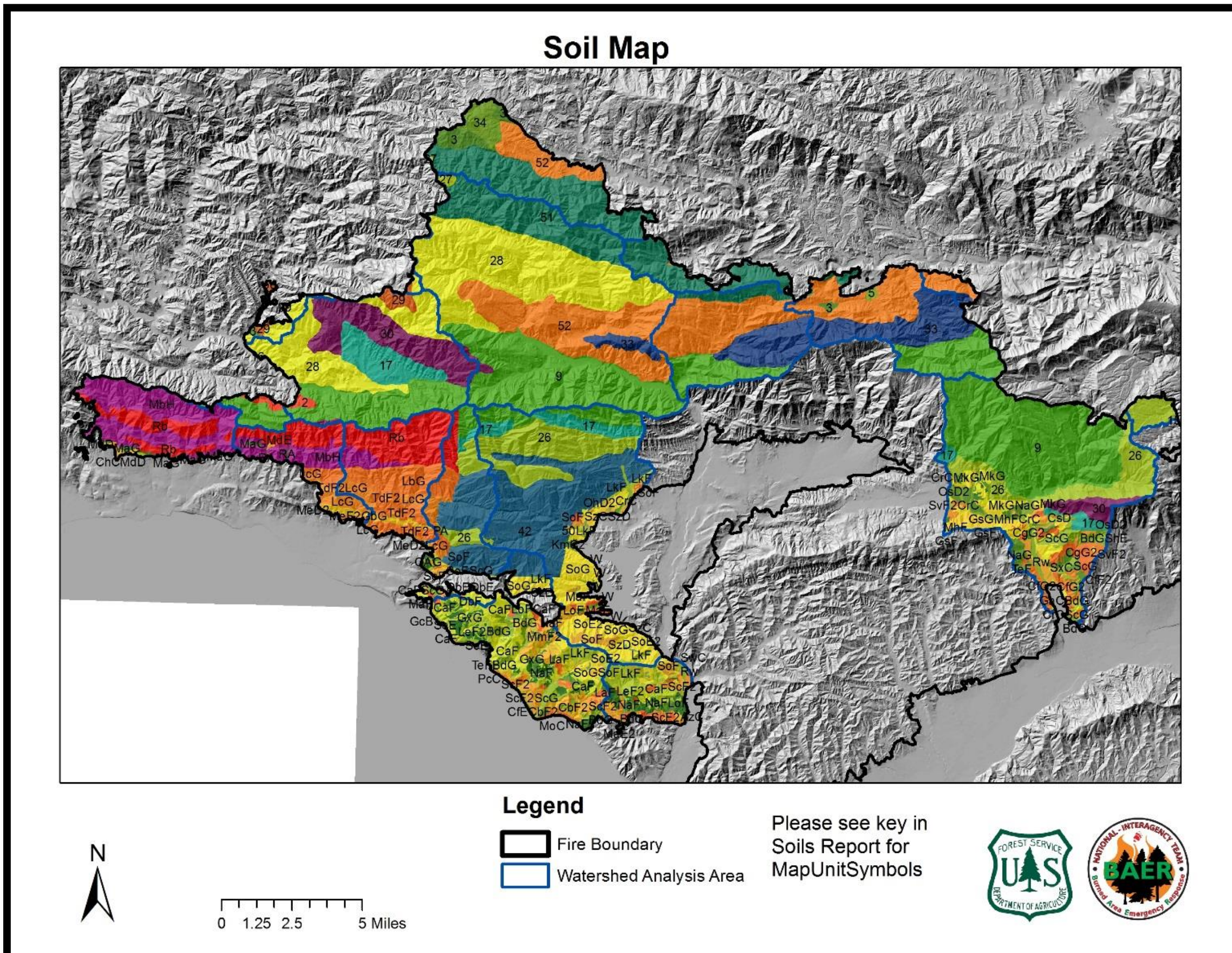

Figure 1: Soils within the Thomas Fire (map unit legend & acreages are in Appendix A).

Access in the fire area for field assessment was good along upper ridges, with few mid-slope roads to access mid-slopes and upper canyon areas of many of the watersheds. Field surveys were conducted in part to verify general soil types, but also to assess other factors affecting soil hydrologic function, erosion potential, and fire effects. Such factors include vegetative burn intensity, aspect and slope gradient, slope length and profile, soil cover, duff consumption, soil heating and char, soil structure and aggregate stability, texture, porosity, organic matter, fine root condition, and water repellency. These more detailed and GPS-located survey points were supplemented with numerous additional spot checks between to quickly assess water repellency and soil heating characteristics in more locations along travel routes. A couple unburned areas were also looked at to gauge fire effects relative to natural conditions for similar soils, particularly with respect to naturally occurring water repellency without fire.

Soil map unit data was combined with field data and site-specific observations to generate interpretations of fire effects upon known (visited) soils, and extrapolate interpretations for unvisited areas. Sediment production modeling estimates were based in part upon soil survey information and modified using field-calibrated data where appropriate.

3. Soil Burn Severity Mapping

Rapid assessment and mapping of soil burn severity (SBS) is necessary for incorporation with other site factors such as soil type, slope, hydrologic characteristics, and biological or human resource values to identify source areas of potential erosion, debris flows, and flooding, and areas where natural or cultural resource values may be degraded.

A Burned Area Reflectance Classification (BARC) map was created by the Remote Sensing Applications Center (RSAC, Salt Lake City, Utah) using satellite imagery and specialized pre-post differential (dNBR) processing methods. Systematic and locational editing is often necessary to finalize the BARC into a map reflecting actual (belowground) soil burn severity as assessed by the team in the field.

An advance team with Team Leader Eric Nicita was assembled to ground verify and produce the SBS map prior to Federal (BAER) and California State (WERT) team formation to assess the values at risk. The SBS map was assessed in two different phases due to the size of the fire and the need to expedite the assessment process. The first phase included the watershed areas that directly affect the town of Ojai, an area approx. 42,000 acres. The second phase included the rest of the fire within the 12/31/17 perimeter, approx. 240,000 acres. The 12/31/17 perimeter was ultimately the final perimeter for the fire, last republished by NIFC (for this reporting) on 1/7/18 with the same footprint.

The final soil burn severity map is in Appendix A. The SBS map is essential input for post-fire erosion, debris flow, and hydrologic modeling efforts, to produce the 3 "hazard maps" standard to a full fire assessment. The SBS map itself is not a hazard map per say.

Phase I – Ojai area

Landsat 8 imagery was acquired for this portion of the fire. The satellite scene only covered roughly Ventura County. A short team of 3 people assessed this portion. Much of the area was inaccessible on the ground so there was high reliance on aerial reconnaissance.

The fire was still burning and obscured by smoke by the time of satellite acquisition and aerial recon. The northeast and northwest portions of Matilija Creek had to be added, but there is high confidence that it did burn at moderate soil burn severity. There was also an area south of Ojai that was burning actively and the original data showed this as unburned. We did not visit this site on the ground but it is a safe assumption that it burned mostly at moderate soil burn severity and the Soil Burn Severity map was adjusted accordingly. Both low/moderate and moderate/high burn severity breaks were separated at higher severities than ground verification suggested, so the breaks had to be scaled down to lower breaks. Due to both high winds (relating to shorter fire residence time on the soil) and relatively sparse ground fuels (low total BTUs for soil heat production) the high soil burn severity was scaled down significantly. This is fairly typical for chaparral, and especially for fast-moving fires.

Phase II – Remainder of fire area

The BARC imagery (Sentinel 2) was clear for the rest of the fire. A team of 7 earth scientists evaluated the non-Ojai area. There was good spatial variability for ground access but the evaluation of the remote and steep upper-country such as upper Matilija was reliant on aerial reconnaissance.

The same general edits were done as on the Ojai section. We did make one local edit. Much of the area is very rocky soil derived from geology comprised of white/grey sandstone yet had mature chaparral & oak communities which affected the quality of the BARC map. These areas were shown as moderate and high SBS even though they were near rubble fields with little soil to affect. To adjust this area, the Coldwater Sandstone (Tcw) geology unit was adjusted separately by significantly reducing the high and moderate burn severity. This area was then used to update the larger SBS map after systematic adjustment of class breaks for the greater fire area.

Results

Soil burn severity acres are listed in table 1 by watershed and/or sub-shed in the phase 2 analysis area (figure 1). These watersheds are clipped to the fire perimeter for analysis. The SBS map can be found in appendix A. This data was immediately furnished to cooperators as a GIS layer for further analysis efforts. Overall SBS in the Thomas Fire was 10% unburned, 23% low, 65% moderate, and 1.5% high.

Table 1. Soil Burn Severity, acres by 6th field watershed.

Acres of Soil Burn Severity by Watershed					
Watersheds	**Unburned**	**Low**	**Moderate**	**High**	**Total**
Abadi Creek-Sespe Creek	5,681	2,568	1,502	35	9,786
Agua Caliente Canyon	244	447	735	6	1,432
Blue Canyon-Santa Ynez River	155	297	940	2	1,394
Carpinteria Creek	49	1,350	6,674	48	8,121
Coyote Creek	1,158	7,381	12,415	217	21,170
Gibraltar Reservoir-Santa Ynez River	2	2	0	0	4
Juncal Canyon-Santa Ynez River	273	1,627	15,106	214	17,221
Los Sauces Creek-Frontal Pacific Ocean	903	3,783	5,986	363	11,035
Lower Ventura River	924	1,420	1,510	3	3,857
Matilija Creek	2,688	4,739	26,735	754	34,917
Mission Creek-Frontal Santa Barbara Channel	535	1,585	5,310	49	7,478
North Fork Matilija Creek	448	1,963	7,765	47	10,223
Piedra Blanca Creek-Sespe Creek	269	318	318	0	904
Rincon Creek	501	2,505	4,799	11	7,816
Santa Monica Creek-Frontal Santa Barbara Channel	100	1,141	3,512	13	4,767
Santa Paula Creek	2,915	6,959	14,179	640	24,694
Tule Creek-Sespe Creek	1,576	2,976	9,068	249	13,869
West Fork Sespe Creek-Sespe Creek	161	258	632	0	1,051
Total	18,582	41,319	117,184	2,651	179,738

Both moderate and high classes have high erosion hazards; both also had water repellency of moderate to high severity and fairly continuous, estimated in 40-60% of these areas. Unburned areas also had low-severity water repellency and was much patchier and less continuous. Thus repellency observed in the burned area was judged as greatly increased (in severity and continuity) by the fire, with a very significant effect on infiltration rates at hillslope and watershed scale.

It must be understood that **soil burn severity is NOT vegetative burn severity or mortality**. Vegetative burn severity is but one component taken into consideration – soil burn severity goes beyond aboveground vegetation impacts to belowground soil heating effects and associated impacts to soil hydrologic function, runoff and erosion potential, and vegetative recovery. Such additional factors include amount and condition of residual ground cover, viability of native seed banks, condition of residual fine roots, degree of fire-induced water-repellency, soil physical factors (texture, structural stability, porosity, restricted drainage), soil chemical factors (oxidation, altered nutrient status), and topography (slope gradient, length, and profile). While above-ground burn severity is more related to peak temperatures and fire behavior during the fire, below-ground soil burn severity is related strongly to the length of time the heat is in contact with the soil (residence time).

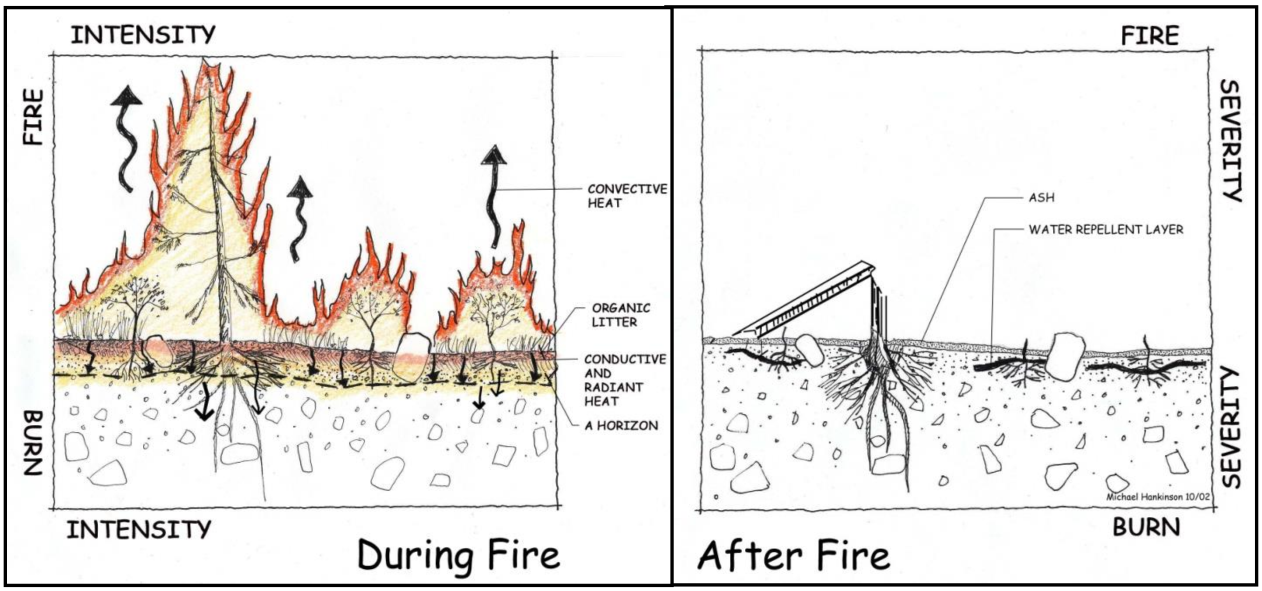

Figure 2: A graphical representation of burn severity vs. fire intensity. Residence time is not represented in the drawing but is a key factor in resulting severity (Effects of Fire-GTR WO-7).

Understanding these differences is crucial to meeting the objectives of the BAER assessment. A high intensity fire (high flame lengths, rapid rate of spread, crown fire, etc.) in a stand-replacement event can result in a moderate (or even low) soil burn severity, if the residence time is short and soil characteristics are not altered significantly. Conversely, a slow-moving fire with complete consumption of accumulated surface fuels can leave vegetation alive, but heat the soil severely with predictable negative consequences to soils and streams. Soil burn severity, used in this context, is a much better index of soil damage, watershed response, and potential for natural vegetative recovery after the fire.

<u>Soil Burn Severity Indicators used for the Thomas fire are generalized best in Parsons et al., 2010:</u>

Low soil burn severity: Surface organic layers are not completely consumed and are still recognizable. Structural aggregate stability is not changed from its unburned condition, and roots are generally unchanged because the heat pulse below the soil surface was not great enough to consume or char any underlying organics. The ground surface, including any exposed mineral soil, may appear brown or black (lightly charred), and the canopy and understory vegetation will likely appear “green.”

Moderate soil burn severity: Up to 80 percent of the pre-fire ground cover (litter and ground fuels) may be consumed but generally not all of it. Fine roots (~0.1 inch or 0.25 cm diameter) may be scorched but are rarely completely consumed over much of the area. The color of the ash on the surface is generally blackened with possible gray patches. There may be potential for recruitment of effective ground cover from scorched needles or leaves remaining in the canopy that will soon fall to the ground. The prevailing color of the site is often “brown” due to canopy needle and other vegetation scorch. Soil structure is generally unchanged.

High soil burn severity: All or nearly all of the pre-fire ground cover and surface organic matter (litter, duff, and fine roots) is generally consumed, and charring may be visible on larger roots. The prevailing color of the site is often “black” due to extensive charring. Bare soil or ash is exposed and susceptible to erosion, and aggregate structure may be less stable. White or gray ash (up to several centimeters in depth) indicates that considerable ground cover or fuels were consumed. Sometimes very large tree roots (> 3 inches or 8 cm diameter) are entirely burned extending from a charred stump hole. Soil is often gray, orange, or reddish at the ground surface where large fuels were concentrated and consumed.

4. Estimated Erosion Response

The ERMiT (Erosion Risk Management Tool) model was used to predict the erosion rates and spatially display erosion source areas. ERMiT is a WEPP-based application developed by USFS Rocky Mountain Research Station (USFS, RMRS-GTR-188, 2007) specifically for use with post-fire erosion modeling. ERMiT models erosion potential based on single hillslopes, single-storm “runoff events,” and post-fire soil burn severity. Hillslopes include soil and topography inputs. Hillslope gradients and profiles were developed in GIS by soil map units, sub watershed, and soil burn severity class to account for fairly site specific differences in topography. Approximately 480 such hillslopes were generated for model inputs for the Thomas fire. These hillslopes were processed using the batch-module of ERMiT.

Two custom climates were created using ROCKCLIME (FS-WEPP) representing the north and the south side of the fire, as calibrated from the NRCS historic climate raster for the area. The erosion modeling is strongly dependent on soil properties, specifically soil texture and rock content. The soil survey that covers a majority of the fire is mapped at lower than normal resolution (closer to Order 4) which gave poor resolution to associated soil properties for modeling, compromising utility of the output. We found that the Geology of the Central Santa Ynez Mountains, Santa Barbara County, CA (Diblee, 1966) had much better resolution, which includes enough information to derive the soil properties necessary for spatial attribution. The geology of the area is strongly stratified between marine sandstones, siltstones and shales, with predictable soil texture and rock content relationships. These geology-soil relationships were developed in conference with the team geologist, and used for modeling to produce a superior map than the soil layer itself produced. The erosion map reflects the lithologic stratification, which is considered appropriate here. The soil texture map (Appendix A) was the product of this exercise and was used to develop the hillslopes that became ERMiT input.

Various storm runoff-event magnitudes may be chosen in ERMiT for erosion response estimates, which is appropriate for hazard and risk type assessments. 2-year and 10-year events were chosen for this analysis, and most of the reported results are based on the 10-year runoff event to be consistent with hydrologic modeling and WERT team efforts. It should be noted that 2-yr and 10-yr recurrence interval storm events that the hydrologist would model are similar but not precisely the same as runoff events.

ERMiT quantitative output should not be interpreted as precise nor overly site specific on the map. Stated model accuracy is +/- 50%, so estimates may be over- or under-estimated. Results are a product of rapid assessment procedures, and the primary intent is to produce a map that helps identify greater or lesser erosion source areas on a relative basis in the greater fire area. This tool is not a prediction of watershed response per say, rather it predicts the relative amount of soil that can be transported from the slopes to the base of slopes, which may or may not be stream channels. Furthermore, the model estimates only sheet and rill erosion, which occurs when rainfall exceeds infiltration rates and surface runoff entrains surface soil particles. The model does not account for shallow debris sliding or gullying, road effects, or fire-line erosion and gullying, which could each pose large additional sources of sediment entering the stream systems.

Approximately 281,893 acres are within the fire perimeter, with approximately 135,546 acres of Forest Service lands burned. The assessment area for erosion modeling was approx. 179,908 acres; there are some small discrepancies in acreages reported due to coordinate system projection errors in some of the source data (such as the NIFC fire perimeter). Precision of acreage figures could be cleaned up later.

ERMiT erosion rate output is extrapolated on a weighted per-acre basis in sub-watersheds to generate totals. The erosion rates can also be spatially displayed to identify areas with the higher sediment source potential. All 6th field watersheds within the Forest Service property and the front country of Santa Barbra and Montecito were included. The watersheds and acres that were excluded were the phase 1 Ojai area and portions in Ventura County where a separate analysis using a local model will be used. This decision was made in conjunction with WERT teams and Counties focused on private lands.

Table 2. Sediment Production (tons) for 2 and 10 year "runoff events" for erosion-modeling area.

		2-Year Event	10-Year Event
Ownership	Acres	Sed. Production	Sed. Production
Federal	135,574	1,797,009	5,238,479
Other Gov/Public*	2,125	25,187	64,049
Private	42,038	463,959	1,237,497
Total	179,738	2,286,154	6,540,025
*Othe gov/public includes city, county, state, and water districts			

Post-fire summary erosion rates and sediment production totals are shown in tables 2 and 3. For the total fire area, erosion rates are modeled at 12.7 tons/acre for a single 2-year runoff event, and 36.4 tons/acre for a 10 year event. More detailed information is available and on file with the authors.

Table 3. Hillslope Sediment Production Rates by 6th field watershed.

		2-Year Runoff Event		10-Year Runoff Event	
		Erosion Rate	Sed. Production	Erosion Rate	Sed. Production
HUC6 Watershed (clipped to fire perimeter)	**Acres**	**(tons/ac)**	**(tons)**	**(tons/ac)**	**(tons)**
Mission Creek-Frontal Santa Barbara Channel	7,478	12.8	95,575	33.9	253,452
Santa Monica Creek-Frontal Santa Barbara Channel	4,767	12.9	61,340	34.8	165,863
Carpinteria Creek	8,121	13.7	111,573	36.6	297,616
Rincon Creek	7,816	11.9	93,219	32.8	256,447
Coyote Creek	21,170	12.1	255,405	32.4	686,754
Los Sauces Creek-Frontal Pacific Ocean	11,035	13.4	147,527	32.2	354,952
Lower Ventura River	3,857	11.0	42,343	25.9	99,865
Gibraltar Reservoir-Santa Ynez River	4	4.8	19	15.1	59
Blue Canyon-Santa Ynez River	1,394	11.5	16,070	37.8	52,699
Agua Caliente Canyon	1,432	12.9	18,542	37.5	53,635
Juncal Canyon-Santa Ynez River	17,221	15.8	271,449	46.5	800,669
Matilija Creek	34,917	14.8	515,496	44.2	1,544,802
North Fork Matilija Creek	10,223	14.5	147,720	44.4	454,327
Abadi Creek-Sespe Creek	9,786	7.1	69,350	20.0	195,734
Tule Creek-Sespe Creek	13,869	12.7	176,610	39.5	548,245
Piedra Blanca Creek-Sespe Creek	904	8.7	7,891	31.5	28,486
West Fork Sespe Creek-Sespe Creek	1,051	7.2	7,528	25.4	26,686
Santa Paula Creek	24,694	10.1	248,498	29.1	719,735
Grand Total	**179,738**	**12.7**	**2,286,154**	**36.4**	**6,540,025**

Regardless of the accuracy of absolute numbers, the model is used here for relative rating of different areas within the fire for relative potential as sediment source areas. Matilija Creeks and Juncal Canyon have the highest erosion rates, and 3 of the 4 Sespe sheds have lower erosion rates about half of that.

Sometimes we see order of magnitude differences between sheds driven mainly by different SBS ratios; here the dominance of moderate SBS and lack of high is driving a fairly small range of erosion rates.

Most watersheds have erosion rates between 10-15 tons/acre for a 2-year runoff event. These are in the high end of what we would normally consider acceptable with respect to natural recovery versus considering slope treatments to stabilize soils; rates over 20 tons/acre for a 2-year event are more of a concern (author's personal opinion). Where these occur in this fire (map, Appendix A) are on very steep slopes where stabilization treatments would not be very effective, and thus not cost effective. Treating lower gradient slopes with lower erosion rates does not generally reduce total sediment production effectively at watershed scale, and thus is not generally cost effective either. Substantial areas in 20-60% slope gradients and high erosion rates are the most cost effective to treat and make a significant difference at watershed scale.

5. Values at Risk – Threats to Life, Property, Soil Productivity, and Water Quality

Soil quality and hydrologic function throughout the fire was assessed by determining soil burn severity, soil erosion hazards, and evaluating potential on- and off-site effects of topsoil loss and sediment production. The combination of soil types, steep slopes, and lack of soil cover will create watershed responses with greatly elevated erosion potential and sedimentation, the degree depending upon the severity of coming storm events over the next 3-5 years or more. On-site effects include the physical, chemical, and biological response of the soils to the fires, and likely recovery rates. Off-site effects due to sedimentation and stream bulking are downstream, and include potential adverse effects to life and property, and natural and cultural resources. More specifically, NFS road and trail infrastructure is at high to very high risk, as well as habitat security for several T&E species. Downstream off of NFS lands, private communities are at high to very risk from debris flows, mudflows, and flooding; water quality for domestic use will likely be compromised in some communities. Reservoirs are also present in the fire area, which are high-value concerns not addressed by BAER per program policy restrictions.

On-site effects of the fire to soils will be some loss of topsoil via accelerated erosion, and some damage to soil nutrient status and microbial communities. This may pose a detriment in the form of declined soil fertility and ecosystem productivity in the short-term. Soils are generally characterized as low site quality before the fires, being mostly poorly-developed soils in a relatively low-rainfall climatic zone, so soil productivity in and of itself was not identified as a value at risk. Likewise, there are no rare plants or vegetation communities present in the fire area that would raise the level of concern with on-site soil productivity to a value at risk for ecosystem stability.

Off-site effects of the fire will be accelerated sediment production into stream systems, stream bulking, downstream deposition of sediment in stream habitats, and increased landslide, mudslide, and debris-flow potential. Sediment-laden ("bulked") runoff and stream water has much greater erosive power and damage potential than similar flows of clean water in the stream system. Many off-site values are at very high risk, threatened by increased stream bulking and debris flow activity. Private residences and roads exist downslope of the fire area, particularly in the Santa Barbara to Carpinteria front country, Ojai, and in Matilija Canyon. These risks are being assessed by state WERT teams, armed with modeling products furnished by the BAER team and USGS. Transportation systems are potentially at devastating risk from debris flows, both on and off of NFS lands, possibly including highway 101 that connects this region of the coast given a very large storm event.

Additional values at risk are present regarding archaeological sites and critical habitat for threatened & endangered species. This information is sensitive in nature, and is not discussed here.

Hazards to these values at risk are judged to NOT be substantially reduced by targeting upslope land treatments to reduce hillslope runoff and sediment bulking of stream waters; this is due to the topography, relief, and steepness of headwater source areas, as well as the timing and feasibility of getting any treatments implemented at this time of year. It is being actively communicated with cooperators that erosion and sedimentation are thus expected to contribute to debris flows and mudflows, which would have a high potential to threaten life and property, as well as water quality. Risk management measures other than slope treatments need to be developed for communities at risk as rapidly as possible, i.e. measures to keep people out of harm's way.

6. Emergency Determination

Effects of the fire on the soils have created emergency conditions, posing hazards to critical values at risk. These soils are naturally prone to flashy runoff and erosion, and have been affected by the fire with complete removal of soil cover and moderate to high levels of water repellency. This will significantly increase peak flows, runoff, stream bulking, flooding and debris flow hazard, and downstream sedimentation. These conditions pose unacceptable threats to values at risk, specifically to road and trail infrastructure on NFS lands, and life, property, and water quality below NFS lands.

Natural recovery will be relied upon for soil risk management on NFS lands. Administrative closure as well as hazard signage will be used to mitigate risks to life and safety on NFS roads and trails, as well as active treatments to protect infrastructure value. Threats to values at risk including life and property downslope of burned NFS lands are not manageable by BAER treatment actions. Unfortunately, due to the very steep terrain most of the erosion source areas are not effectively treatable.

7. Treatments to Mitigate the Emergency

It is possible to have emergency conditions without the ability or justification to do something about it. The BAER Program requires that proposed mitigative treatments must be proven effective, technically feasible, justified by the values at risk, and of a magnitude to make a meaningful difference in reducing risk levels. Proposed treatments are considered the minimum necessary response to significantly reduce the threat to the values at risk. In this context the suite of possible treatments and treatment locations are scrutinized and narrowed to the minimum necessary response to manage and reduce risk levels to acceptable levels, or as close as we can feasibly achieve toward that objective given reasonably expectable magnitudes of damaging events.

In this fire there are many locations having very serious watershed response hazards threatening private life and property values downstream, with flood and debris source areas on NFS lands. In this case we do not have the ability to apply land treatments in the source areas, primarily because terrain is mostly too steep for treatments to be effective, and secondarily because we are already in the winter season and we cannot implement large treatment areas prior to damaging events. This situation is such that treatment efforts would not be meaningful or effective in achieving risk reduction objectives.

Flow and erosion rates will still be elevated for several years, so threats to life and property will still exist, just at lower risk levels for less than "worst-case" storm scenarios. Several downstream communities outside of the burn area will need to remain vigilant and aware of the potential for flash floods and debris flows with certain size rain events. County OEM is aware of the situation and the need to continue messaging and mitigation efforts moving forward over several years.

8. References

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Soil Resource Inventory. USDA Forest Service, Plumas National Forest, 1988.

Parsons, A., P.R. Robichaud, S.A. Lewis, C. Napper, J.T. Clark, 2010. Field Guide for Mapping Post-Fire Soil Burn Severity. USDA Forest Service General Technical Report RMRS-GTR-243, 2010.

USDA Forest Service. 1990. Soil erosion hazard rating. Soil and Water Conservation Handbook, Ch. 50, R-5 FSH 2509.22, R5 Amend. 2. PSW Region, Vallejo, California.

USDA Forest Service, Effects of Fire on Soil, National Fire Effects Workshop, GTR WO-7.

USDA, 2014. Erosion Risk Management Tool (ERMiT). U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Moscow, ID. Online at: http://forest.moscowfsl.wsu.edu/fswepp/

Appendix A – Maps

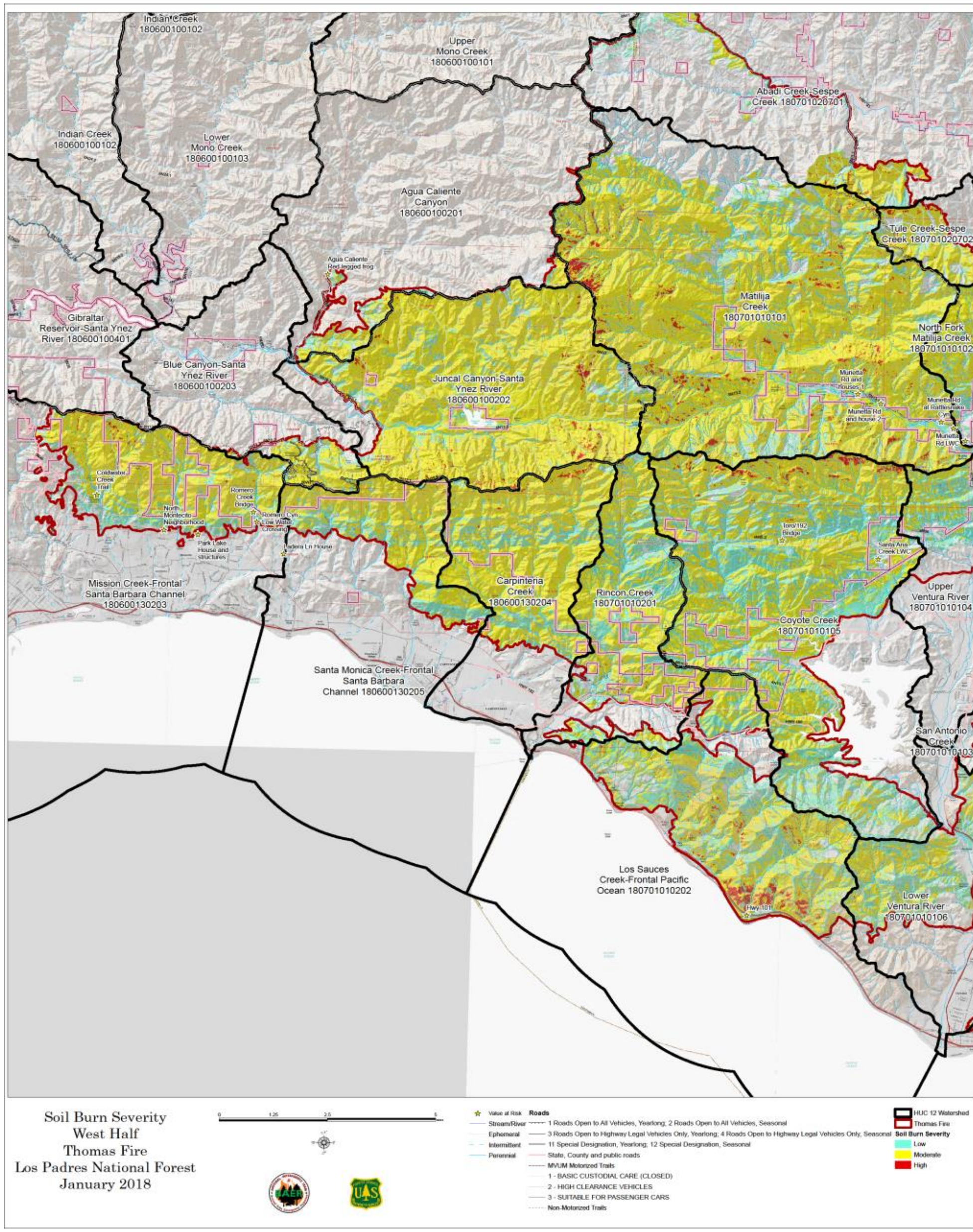
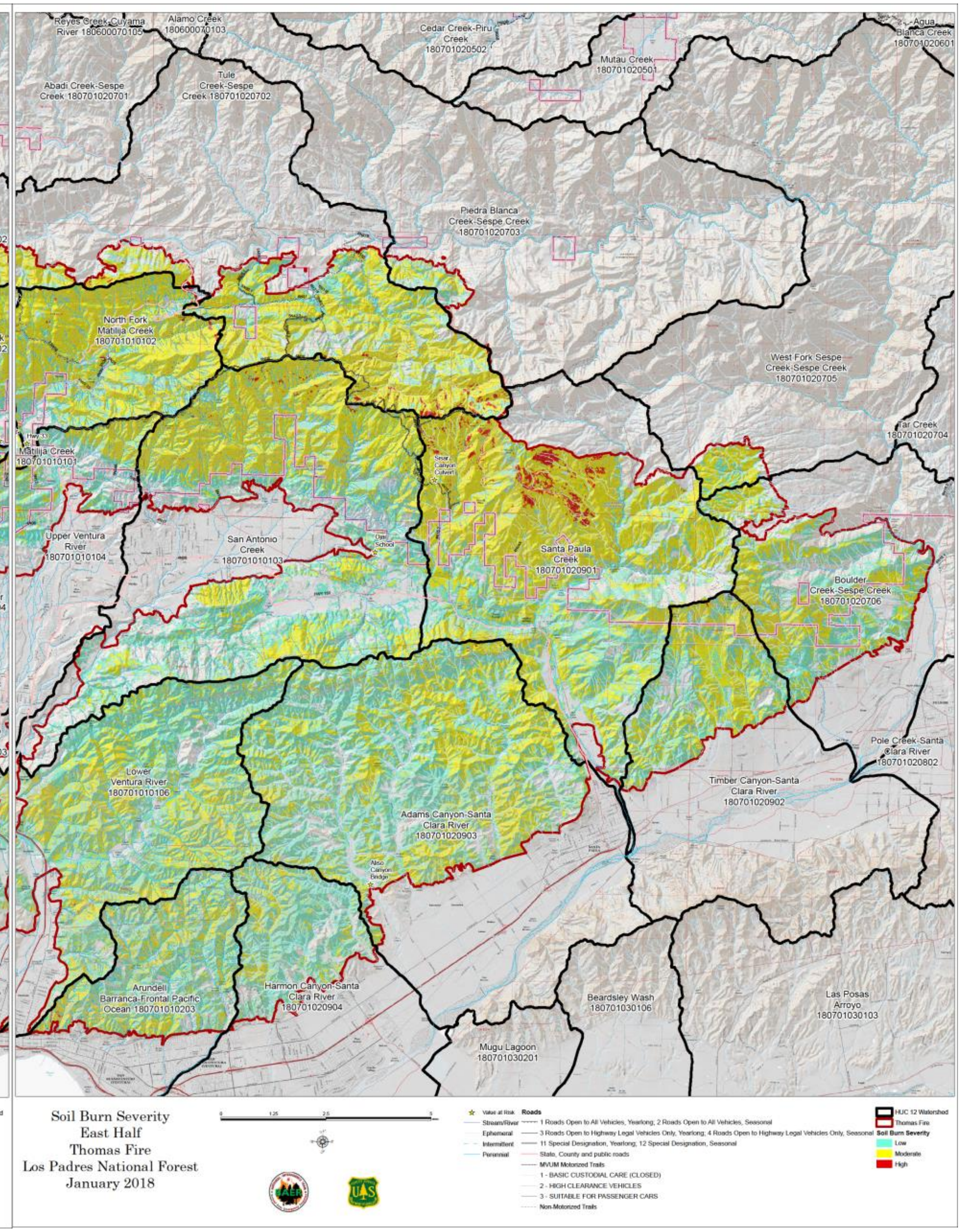
The USDA Forest Service uses the most current and complete data available. GIS data and product accuracy may vary. They may be: developed from sources of differing accuracy, accurate only at certain scales, based on modeling or interpretation, incomplete while being created or revised, etc. Using GIS products for purposes other than those for which they were created, may yield inaccurate or misleading results. The Forest Service reserves the right to correct, update, modify, or replace, GIS products without notification. If this map contains contours, these were generated and filtered using the Digital Elevation Model (DEM) files. Any contours generated from DEMs using a scale of less than 1:100,000 will lead to less reliable results and should be used for display purposes only. For more information, contact:

Los Padres National Forest
6750 Navigator Dr., Goleta, CA 93117
(805) 968-6640

MULTIPLE GIS-PRODUCED MAPS FOLLOW

DISCLAIMER:
The Soil Burn Severity (SBS) map is a product of BAER rapid assessment; the map is not intended to be 100% accurate and the data represented is provisional in nature. The map is based upon satellite imagery, and then field verified and revised by the assessment team. The primary purpose of this map is for erosion and watershed response modeling, NOT for assessing vegetation impacts of the fire ("RAVG" mapping derived from the same imagery is better suited for this purpose). Above-ground appearances are not reliable indicators of below-ground soil effects.

Data users are advised to be exercise due caution and carefully consider the provisional nature of the information before using it for decisions that concern personal or public safety or the conduct of business that involves monetary, legal, or operational consequences. Further information concerning the accuracy, limitations, and appropriate uses of these data may be obtained from the Forest BAER Coordinator.


Soil Burn Severity
West Half
Thomas Fire
Los Padres National Forest
January 2018
Indian Creek 180600100102
Upper Mono Creek 180600100101
Lower Mono Creek 180600100103
Agua Caliente Canyon 180600100201
Abadi Creek-Sespe Creek 180701020701
Tule Creek-Sespe Creek 180701020702
Gibraltar Reservoir-Santa Ynez River 180600100401
Blue Canyon-Santa Ynez River 180600100203
Juncal Canyon-Santa Ynez River 180600100202
Matilija Creek 180701010101
North Fork Matilija Creek 180701010102
Carpinteria Creek 180600130204
Rincon Creek 180701010201
Coyote Creek 180701010105
Upper Ventura River 180701010104
San Antonio Creek 180701010103
Mission Creek-Frontal Santa Barbara Channel 180600130203
Santa Monica Creek-Frontal Santa Barbara Channel 180600130205
Los Sauces Creek-Frontal Pacific Ocean 180701010202
Lower Ventura River 180701010106
Value at Risk
Roads
Stream/River
Ephemeral
Intermittent
Perennial
1 Roads Open to All Vehicles, Yearlong; 2 Roads Open to All Vehicles, Seasonal
3 Roads Open to Highway Legal Vehicles Only, Yearlong; 4 Roads Open to Highway Legal Vehicles Only, Seasonal
11 Special Designation, Yearlong; 12 Special Designation, Seasonal
State, County and public roads
MVUM Motorized Trails
1 - BASIC CUSTODIAL CARE (CLOSED)
2 - HIGH CLEARANCE VEHICLES
3 - SUITABLE FOR PASSENGER CARS
Non-Motorized Trails
HUC 12 Watershed
Thomas Fire
Soil Burn Severity
Low
Moderate
High

Soil Burn Severity
East Half
Thomas Fire
Los Padres National Forest
January 2018
Reyes Creek-Cuyama River 180600070105
Alamo Creek 180600070103
Cedar Creek-Piru Creek 180701020502
Mutau Creek 180701020501
Agua Blanca Creek 180701020601
Abadi Creek-Sespe Creek 180701020701
Tule Creek-Sespe Creek 180701020702
Piedra Blanca Creek-Sespe Creek 180701020703
North Fork Matilija Creek 180701010102
West Fork Sespe Creek-Sespe Creek 180701020705
Tar Creek 180701020704
Matilija Creek 180701010101
Upper Ventura River 180701010104
San Antonio Creek 180701010103
Santa Paula Creek 180701020901
Boulder Creek-Sespe Creek 180701020706
Pole Creek-Santa Clara River 180701020802
Timber Canyon-Santa Clara River 180701020902
Lower Ventura River 180701010106
Adams Canyon-Santa Clara River 180701020903
Arundell Barranca-Frontal Pacific Ocean 180701010203
Harmon Canyon-Santa Clara River 180701020904
Beardsley Wash 180701030106
Las Posas Arroyo 180701030103
Mugu Lagoon 180701030201
Value at Risk
Roads
Stream/River
Ephemeral
Intermittent
Perennial
1 Roads Open to All Vehicles, Yearlong; 2 Roads Open to All Vehicles, Seasonal
3 Roads Open to Highway Legal Vehicles Only, Yearlong; 4 Roads Open to Highway Legal Vehicles Only, Seasonal
11 Special Designation, Yearlong; 12 Special Designation, Seasonal
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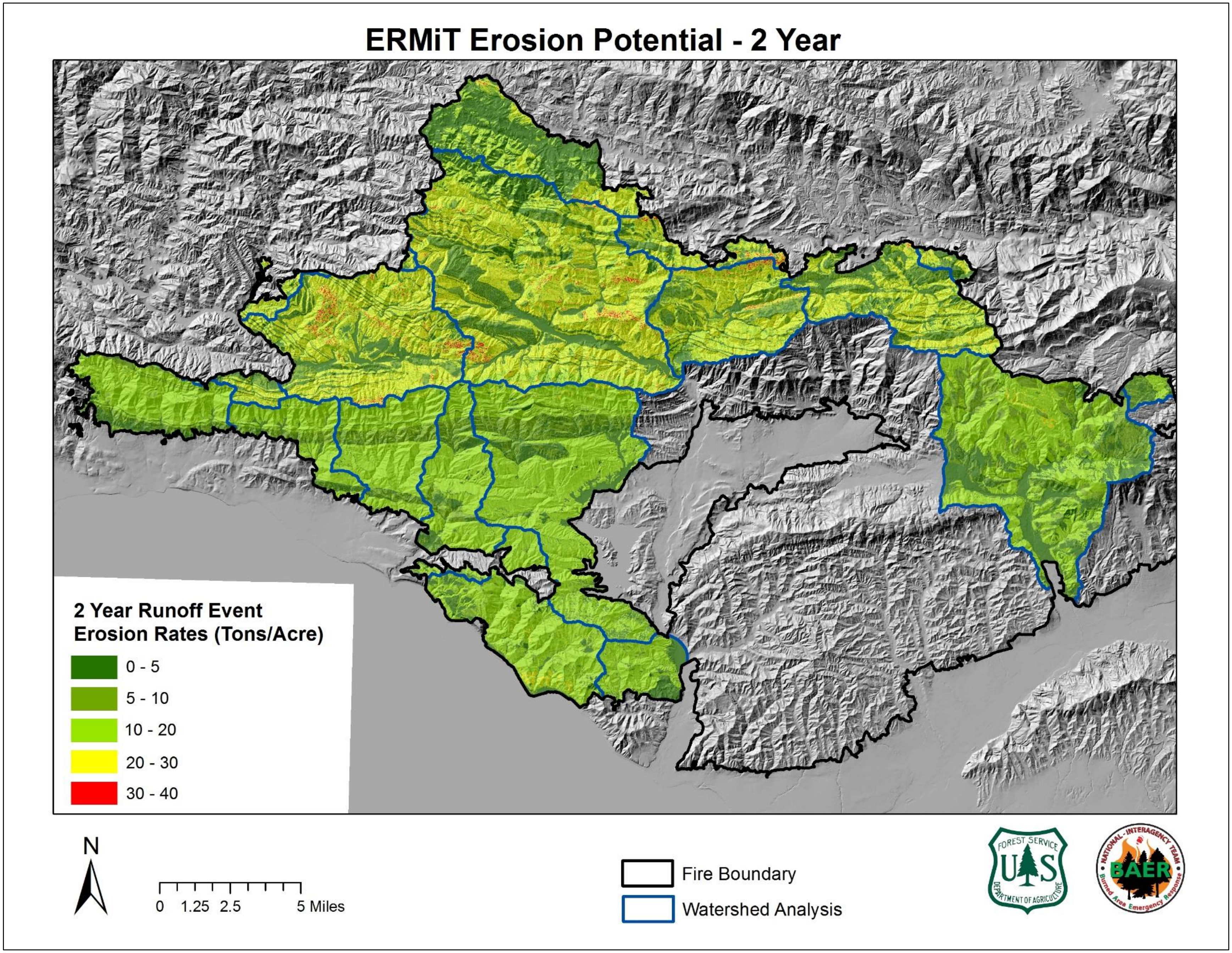
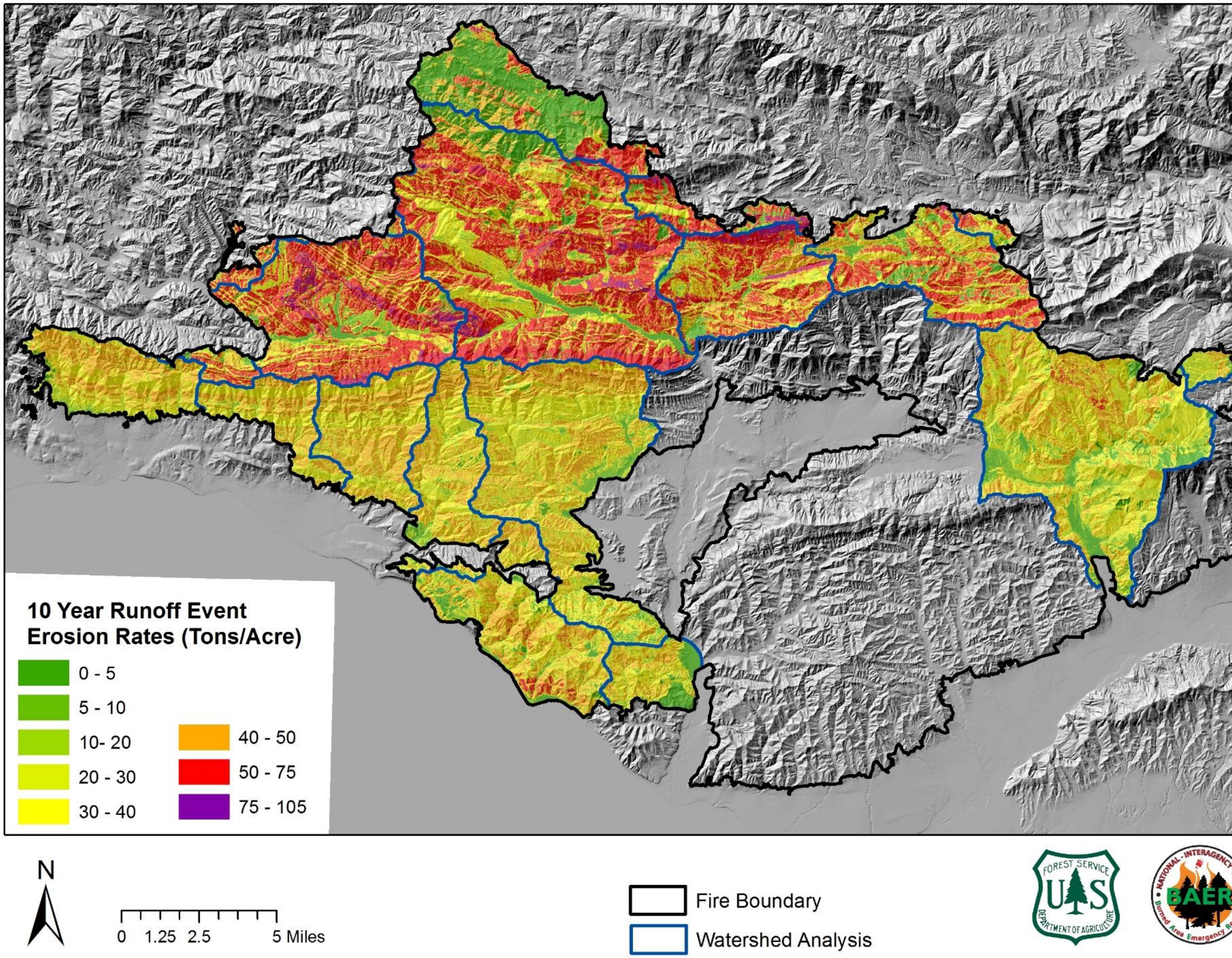
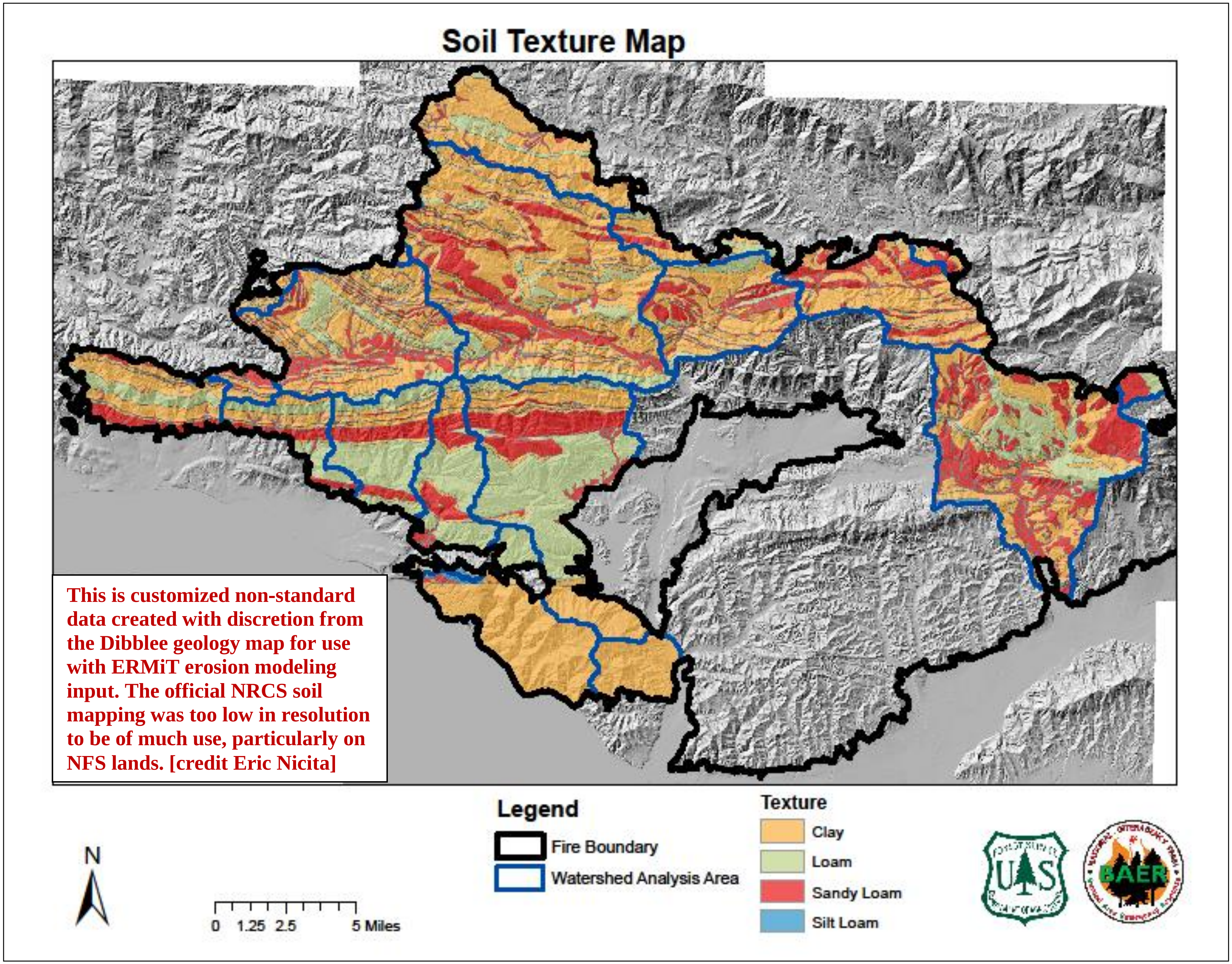
HUC 12 Watershed
Thomas Fire
Soil Burn Severity
Low
Moderate
High


ERMiT Erosion Potential - 2 Year
2 Year Runoff Event
Erosion Rates (Tons/Acre)
0 - 5
5 - 10
10 - 20
20 - 30
30 - 40
N
0 1.25 2.5 5 Miles
Fire Boundary
Watershed Analysis
FOREST SERVICE
U S
DEPARTMENT OF AGRICULTURE
NATIONAL INTERAGENCY TEAM
BAER
Burned Area Emergency Response

ERMiT Erosion Potential - 10 Year




Soil Texture Map
This is customized non-standard data created with discretion from the Dibblee geology map for use with ERMiT erosion modeling input. The official NRCS soil mapping was too low in resolution to be of much use, particularly on NFS lands. [credit Eric Nicita]
Legend
Fire Boundary
Watershed Analysis Area
Texture
Clay
Loam
Sandy Loam
Silt Loam
N
0 1.25 2.5 5 Miles
BAER

NRCS Soil Map Units within the Thomas Fire – this is the map unit legend & corresponding acreages for the soils map in figure 1. Soil data is publicly available data through NRCS Web Soil Survey: https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

Map Unit Code	Acres
13	17
15	0
16	2
17	4669
2	455
26	9617
27	190
28	18073
29	742
3	1132
30	5800
33	7347
34	1043
42	11980
5	129
50	16
51	15436
52	18026
9	33996
AcC	19
AuC2	9
AuD	70
AzC	33
BbC	4
BdG	1355
BkC2	1
BkD2	1
CaF	1949
CbF2	492
CfD2	10
CfE	79
CfF2	251
CfG2	470

Map Unit Code	Acres
CgG2	659
ChC	27
ChD2	9
CnB	45
CrC	602
CsD	143
CyC	61
Cz	4
DA	1
DbD	37
DbE	231
DbF	204
EaB	25
Eb	5
GaC	75
GbC	148
GbG	511
GcB	141
GcC	14
GsE	51
GsF	184
GsG	491
GxG	665
HuE3	4
KmC2	55
KmD2	85
LaF	278
LbG	4144
LcG	2029
LeD2	86
LeE2	304
LeF2	682

Map Unit Code	Acres
LkF	1723
LoD2	20
LoE2	137
LoF	263
MaD2	4
MaE2	53
MaF	324
MaG	206
MbH	7409
McA	18
McC	11
MdD	78
MdE	49
MeC	6
MeD2	47
MeE2	57
MeF2	13
MhF	649
MkG	760
MmF2	856
MoC	72
NaD2	46
NaE2	188
NaF	1446
NaG	492
OAG	130
OhA	17
OhC2	72
OhD2	192
OsD2	510
OsE2	94
PA	18

Map Unit Code	Acres
PcC	43
RA	18
Rb	7297
RcC	5
RcD2	61
RcE2	51
RcE3	15
Rw	243
ScD2	39
ScE2	110
ScF2	1335
ScG	835
SeE	379
SeF	104
ShE	6
ShF2	221
SnG	156
SoE2	508
SoF	932
SoG	4443
SsE2	55
SvF2	244
SwA	1
SwC	81
SxC	215
SzC	273
SzD	214
TbE2	53
TdF2	177
TeF	148
W	166
ZmC	32
ZmD2	12